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WINDOW Update

Vol. 1 No. 1 -- January 1993





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WINDOW 4.0 has been completed and in use for just over six months. This is the first of what we hope will be a semiannual newsletter. Issues will follow more frequently if needed. Our aim is to keep users informed of ongoing issues and plans relating to the use of the program. User comments are welcome. Let us know if you would like a name added to or removed from our mailing list. **Please respond to:**

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1/93 1500 WINDOW 4.0, © Regents of the University of California, is a PC program for analyzing window thermal performance. This work is supported by the Assistant Secretary for Conservation and Renewable Energy, Office of Building Technologies, Building Systems and Materials Division of the U.S. Department of Energy under Contract No. DE-AC03-76SF00098.

**FOR YOUR INFORMATION****FUTURE PROGRAM PLANS / WINDOW 5**

While virtually all WINDOW users are quite pleased with version 4.0 and the program's use is increasing throughout the fenestration industry, a wish list for new and improved features is materializing. Many of the items on this wish list focus on improving the connection between WINDOW and FRAME, including a CAD interface for inputting drawings of window profiles. Other topics of interest are the analysis of shading systems, laminates (see article on page 6), acoustics, angular properties, and the calculation of a Condensation Resistance Factor. The modular program structure being planned may require us to rework much of the code, so this is a good time to get your comments in to us if you have specific requests for the next version. We try and meet requests for program improvements when they are technically and logistically feasible and when they do not conflict with existing or previously planned features.

**WINDOW 4.0 / FRAME 3.0 INTERFACE**

All of the possible combinations of frame and glazing options in a window product line can result in a large number of windows. This translates into a fair amount of time and expense if all options are modeled individually. WINDOW 4.0 includes a link to the frame and edge-of-glass thermal analysis tool, FRAME 3.0 (developed by Enermodal Engineering, Canada). This feature reduces the total number of simulations required to model a product line. The WINDOW/FRAME link affords the user a powerful fenestration thermal analysis tool. However, the process for using this feature is somewhat involved.

The WINDOW/FRAME link makes use of the FRAME 3.0 parametric run feature. This feature allows simulation over a range of center-of-glass properties, and/or a range of glazing thicknesses for a given frame, avoiding the necessity of creating a new simulation file for each and every possible glazing option. Once the FRAME simulation is complete, WINDOW accesses the FRAME data, interpolates between the parametric simulation values as necessary, and calculates the optical and thermal properties of the whole window according to the glazing specified by the user. Complete documentation for this process will be available in early 1993. If you are interested in receiving a copy of this report, please let us know.





USERS WANT TO KNOW



1. HOW TO USE <Alt> L TO OPTIMIZE SPEED AND STORAGE

The new version of WINDOW is capable of handling much larger libraries. For instance, the number of windows that can be stored in the WINDOW LIBRARY has increased from 15 in WINDOW 3.1 to 9999 in WINDOW 4.0. The increased storage capability carries with it a potential disadvantage. Large libraries, containing several hundred entries, slow down the initialization and use of the program. It is therefore desirable to set up parallel sets of smaller libraries containing less than a hundred entries. The entire library structure (see Fig. 1) must be duplicated in the parallel library sets (see Fig. 2 on page 5: throughout this article the sample parallel library sets are in subdirectories referred to as C:/ALTLIBA and C:/ALTLIBB). These alternate sets can then be accessed from within the program using the <Alt> L command. The <Alt> L command is an advanced feature of WINDOW (see section 4.4.2 **Using Another Set of Libraries** on page 21 of the User Manual). This command specifies the default path of the subdirectory containing the set of library files (standard default is \W4LIB). It allows the user to work with small case-specific libraries. Small libraries improve the performance of the program with respect to speed. Case-specific libraries help to organize both input data and results.

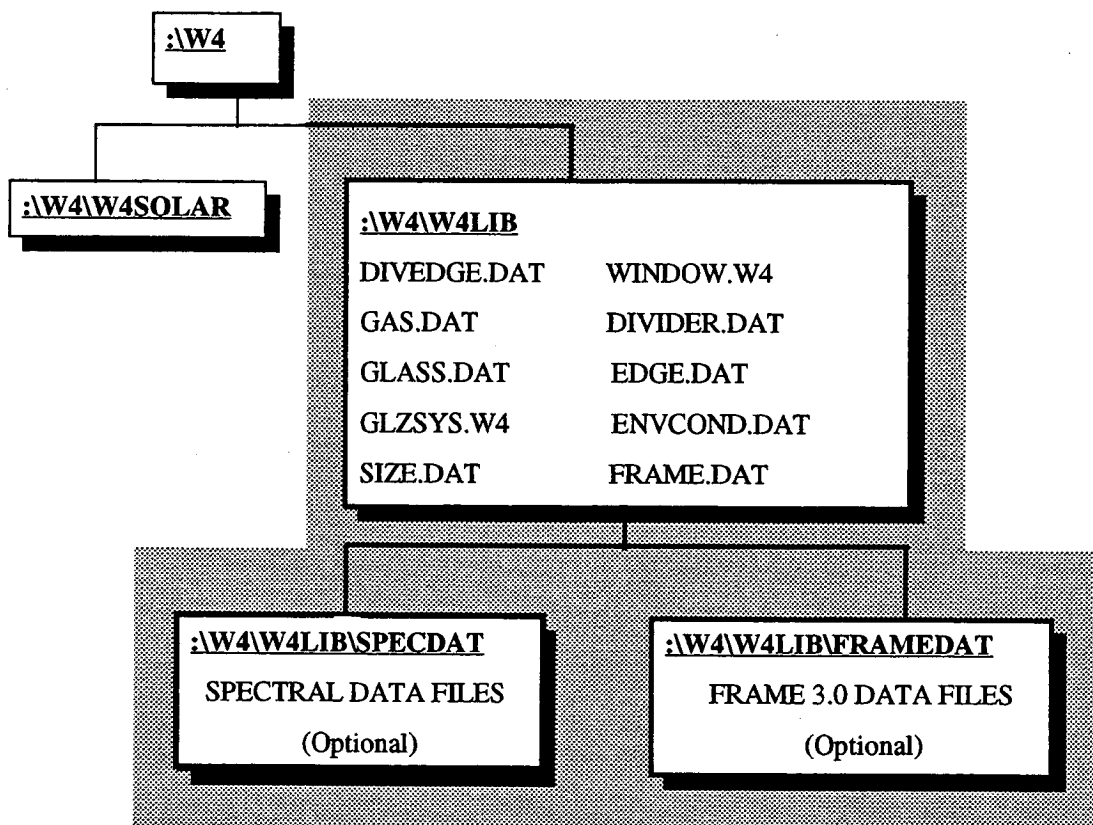


Figure 1: Default structure of WINDOW 4.0 on hard disk. The shaded area indicates the library structure that must be duplicated in each parallel library set.

Use of <Alt> L

The <Alt> L command is designed to reduce the overhead that would result from having multiple copies of the entire WINDOW program on hard disk. With the *Alternate Library Set* option, only the window component library files are replicated. We have received requests for advice on how to further reduce hard disk space when alternate libraries are being used. This issue is of special concern to people who use the FRAME 3.0 program and want to coordinate interaction between WINDOW and FRAME.

By using <Alt> L on the MAIN SCREEN, the user can switch the path name for the library set. The default path is set for \W4LIB. To switch the path to ALTLIBA (see Fig. 2), hold down the <Alt> key and press <I>. Then type C:\ALTLIBA over the existing default name. The program will reinitialize all the libraries. All saves will now be made to the library files stored in C:\ALTLIBA. You can then change the path name again and work with another set of library files. There is no limit to the number of alternate libraries you can select in a single session. The next time you start up WINDOW, **the last alternate library set chosen using <Alt> L will be used as the default path.**

Optimization of Alternate Subdirectories

Here are some possible ways to reduce the disk requirements of your alternate library sets. These suggestions are given to optimize the program with respect to hard disk space. They may limit the program's versatility and should only be used if disk space is a concern.

- ❶ The largest library file is the GLASS.DAT file. Chances are that you will not need all the glass types represented in the distribution version of this file. A customized GLASS.DAT file can be created within the program by deleting unused entries. **BEFORE YOU DELETE ENTRIES FROM THE GLASS.DAT FILE SAVE THE ORIGINAL FILE TO ANOTHER FILE WITH A NEW NAME, i.e., GLASS.OLD.**
- ❷ Both the SPECDAT and FRAMEDAT subdirectories may be empty.
- ❸ Customize the FRAME and DIVIDER LIBRARIES to include only the elements applicable to the alternate library set. You will not, however, be able to delete the protected records.
- ❹ WINDOW will generate new empty libraries if the WINDOW.W4 and/or the GLZSYS.W4 files are not included in the subdirectory. Therefore, these files can be omitted when setting up a new alternate library set.

NOTE TO FRAME 3.0 USERS

FRAME 3.0 allows the user to set the path for the location of the GLAZING SYSTEM LIBRARY and the output *.F30 files. Use of this feature within FRAME will help you organize all the components of your results within the structure provided by WINDOW.

C:

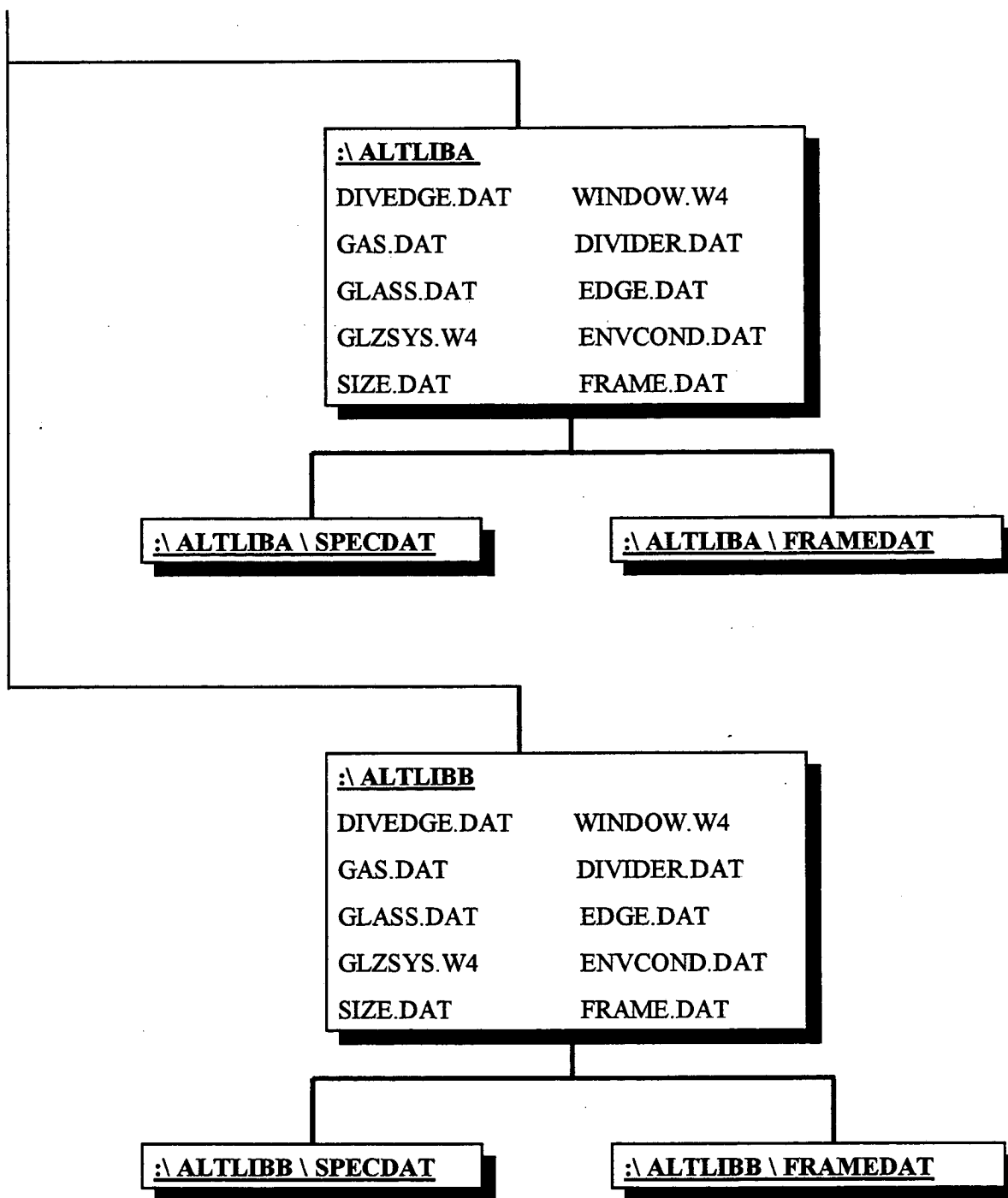


Figure 2 : The minimum files necessary to set up two alternate library sets named ALTLIBA and ALTLIBB.



USERS WANT TO KNOW



2. HOW TO INTERPRET THE TEMPERATURE SCREEN

Feedback from users indicates that the TEMPERATURE SCREEN causes confusion to the new user. Figure 4 shows a sample TEMPERATURE SCREEN. The various sections that make up the screen are labeled with letters and discussed separately to aid in the understanding of this output screen.

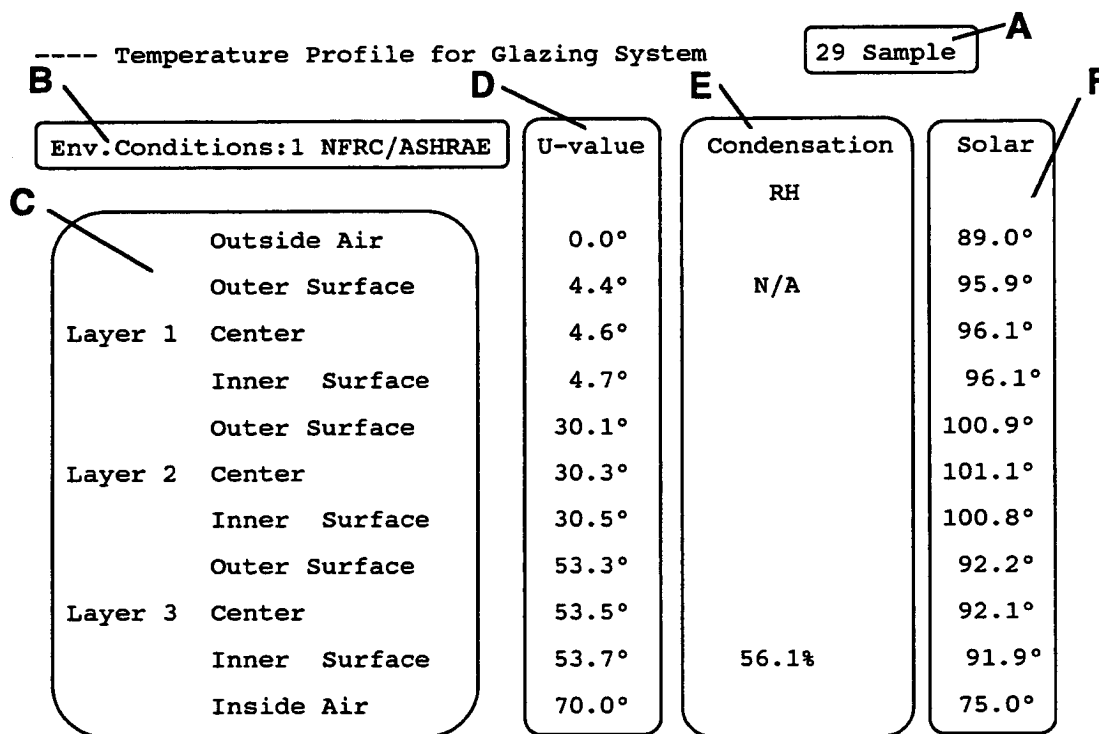


Figure 4: Sample TEMPERATURE SCREEN for a three layer glazing system.

A. This section shows the ID Number and the Name of the glazing system associated with the temperature profile. This information matches the glazing system currently highlighted in the GLAZING SYSTEM LIBRARY. By default the program highlights the glazing system in the window on the MAIN SCREEN. For windows with more than one glazing system, the user can select the glazing system highlighted by placing the cursor on its ID Number.

B. This section names the set of environmental conditions that are being used to determine the temperature profile. The TEMPERATURE SCREEN is linked to the GLAZING SYSTEM LIBRARY. The temperature profile is based on the environmental conditions used to define the glazing system. This may be different than the environmental conditions specified for the window that uses the glazing system. To avoid confusion it is recommended that the glazing system and the window should be designed using the same environmental conditions (See Snag #4 on page 14 of the newsletter). A sample ENVIRONMENTAL CONDITIONS LIBRARY is shown in Fig. 5 on page 8.

C. This section names the locations at which the temperature profile is evaluated. The more graphical representation found in WINDOW 3.1 has been replaced with a simple list. This list is consistent with the format used in defining the glazing system. The layer exposed to the outside temperature is listed first and the layer exposed to the inside temperature is listed last. Three temperatures are listed for each layer: Outer Surface, Center, and Inner Surface. The temperature profile for glazing systems of up to six layers can be displayed. The outside and inside air temperatures, however, are not displayed for a six-layer window due to space limitations.

D. This section gives the temperature profile based on the part of the set of environmental conditions labeled *Uvalue*, see Fig. 5. The temperature profile is reported in the system of units specified on the MAIN SCREEN. It is left to the user to remember if these temperatures are reported in °F (for IP units) or °C (for SI units). For the set of environmental conditions chosen, 1 NFRC/ASHRAE, the *Uvalue* conditions correspond to the **Winter** conditions found in WINDOW 3.1. In order to get the **Summer** U-value found in WINDOW 3.1, the user should specify 3 ASHRAE - SUMMR as the environmental condition.

E. This section provides the relative humidity at which condensation will occur based on the center-of-glass temperature. The relative humidity is calculated based on the *Uvalue* conditions.

NOTE: Condensation occurs first on the coldest part of the glass, typically not the center-of-glass region. Therefore, the relative humidity values based on center-of-glass temperatures must be used with caution. A method for determining the edge-of-glass U-value that will predict condensation resistance at one-quarter inch and one-half inch from the sight line can be found in the September 1990 issue of Progressive Architecture, written by Kenneth Labs in cooperation with researchers at LBL. Let us know if you would like a copy of this article.

F. This section gives the temperature profile based on the part of the set of environmental conditions labeled Solar, see Fig 5. For the set of environmental conditions chosen, 1 NFRC/ASHRAE, the Solar conditions correspond exactly to the **Summer** conditions found in WINDOW 3.1.

| ----- Env Cond Library ----- | | | | | | | | | |
|------------------------------|--------------|--------|----------------------|---------------------|----------------------|-------------------|----------------------------------|-----------|------|
| ID | Name | | Outside Temp F | Inside Temp F | Wind Speed mph | Wind Direction | Direct Solar Btu/h- ft2 | Tsky F | Esky |
| 1 | NFRC/ASHRAE | Uvalue | 0.0 | 70.0 | 15.0 | 0 Windward | 0.0 | 0.0 | 1.00 |
| | | Solar | 89.0 | 75.0 | 7.5 | 0 Windward | 248.2 | 89.0 | 1.00 |
| 2 | ASHRAE-WINTR | Uvalue | 0.0 | 70.0 | 15.0 | 0 Windward | 0.0 | 0.0 | 1.00 |
| | | Solar | 0.0 | 70.0 | 15.0 | 0 Windward | 0.0 | 0.0 | 1.00 |
| 3 | ASHRAE-SUMMR | Uvalue | 89.0 | 75.0 | 7.5 | 0 Windward | 248.2 | 89.0 | 1.00 |
| | | Solar | 89.0 | 75.0 | 7.5 | 0 Windward | 248.2 | 89.0 | 1.00 |

Figure 5: Distributed ENVIRONMENTAL CONDITIONS LIBRARY.

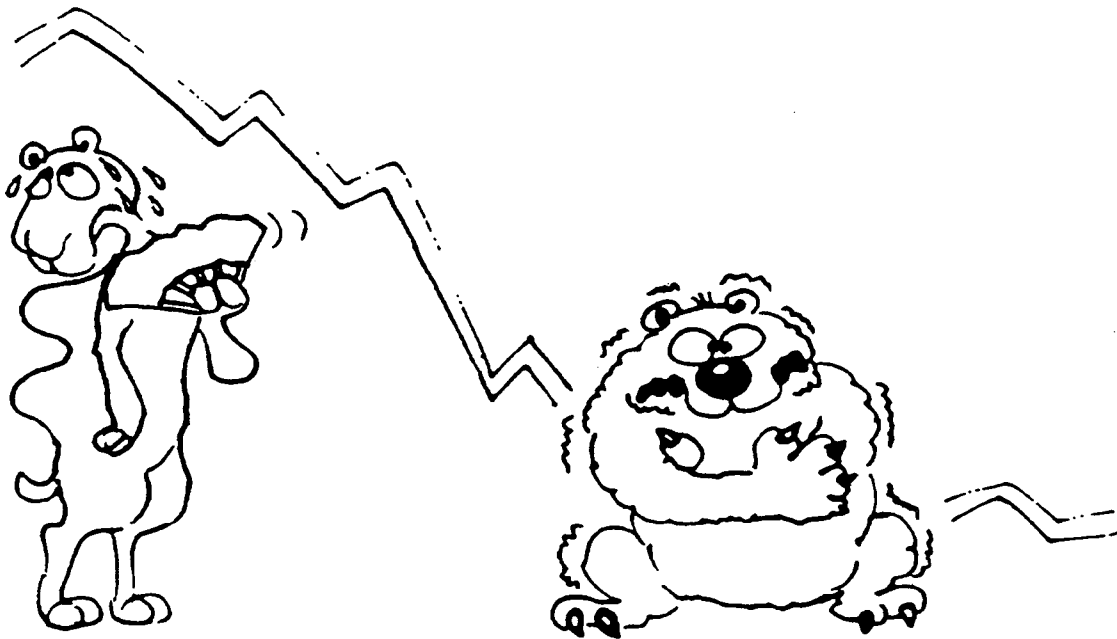


Illustration by Jean-Michel Nataf



USERS WANT TO KNOW



3. HOW TO MODEL LAMINATES IN WINDOW 4.0

There are examples of laminated glass products in the GLASS LIBRARY provided with the WINDOW 4.0 program. Two companies have provided data, DuPont and Monsanto. This data is for a laminated assembly (glass + laminate + glass, see Fig. 3). **Please make note of Bug #3 on page 13 of this newsletter regarding the Monsanto data.**

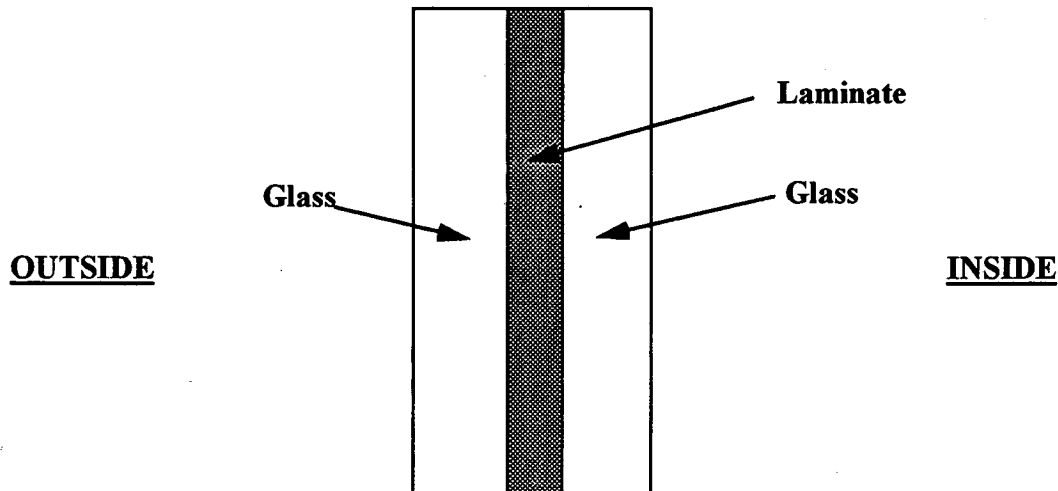


Figure 3: Schematic representative of the laminated glass products found in the distributed GLASS LIBRARY.

Many people, however, would like to analyze the performance of laminates created from individual layers in the WINDOW 4.0 GLASS LIBRARY. In response to this, we are working to create a preprocessor that will allow the user to create laminates from existing spectral data files. The existing single layer spectral data files contain values for transmittance and reflectance obtained from a spectrophotometer. In all cases the glass layer had an air/solid interface on both surfaces. In order to obtain optical properties for a laminated assembly, the spectral dependence of the index of refraction and in some cases the absorption coefficient must be known. This information must be known for each layer in the laminate assembly including any adhesive. Before a preprocessor can be released, more data representing the broad range of materials used in laminated assemblies is needed.

Please note that it is not physically realistic to model a laminated product by creating a multi-layered glazing system with an air gap of 0.0. For weakly absorbing materials, the reflectivity is dependent on the values of the refractive index at the interface:

$$\rho = \frac{n_1 - n_2}{n_1 + n_2}$$

For air, the index of refraction, n_2 , equals 1.0. If glass or adhesive replace air at the interface, the value of the reflectivity would change. The magnitude of the error that such an approximation would introduce cannot be determined unless the index of refraction of the material replacing air at the interface is known.



USERS SPEAK UP ABOUT THE IG U-VALUE



Some valid concerns about WINDOW were expressed at the SIGMA Summer Meeting . Here is our response to some of the questions.

What happened to the IG U-value?

Within WINDOW 4.0 the information on how the spacer effects the edge-of-glass U-value is included in the FRAME LIBRARY. Because of this, there is no direct way of including the effect of the spacer on the insulated glass unit alone. The IG U-value was intentionally left out of WINDOW 4.0 because of its potential for providing misleading results. IG U-values can either overpredict or underpredict thermal performance depending on the end use of the insulated glass unit.

How can I create the old IG U-value in WINDOW 4.0?

Keeping in mind that it is not the recommended procedure, the IG U-value can be recreated within WINDOW 4.0 in the following way:

1. First design your insulated glass unit within the GLAZING SYSTEM LIBRARY.
2. Then create a frame with a thickness that is effectively 0.0, for instance 0.001. Specify the edge U-value either by choosing one of the edge correlations provided or by including your own data.
3. Finally, go to the MAIN SCREEN and select a picture window. Specify the size of the IG unit. You will probably want to use the *CUSTOM* Size option. Then specify the glazing system and frame you have defined previously. The total U-value displayed on the MAIN SCREEN is equivalent to the IG U-value reported in WINDOW 3.1. Save your window to the WINDOW LIBRARY to view the U-values of several IG units at one time. The contents of the library can be printed out by using the <Alt> P command within the WINDOW LIBRARY.

What's wrong with the IG U-value?

The IG U-value provides potentially misleading results about the thermal performance of IG units. This value is primarily of interest to show how spacer design affects the performance of the IG unit. There are two major reasons why an IG U-value is not a good way of modeling the spacer effect.

First, the spacer does more than affect the edge-of-glass U-value since it can also affect the frame U-value. This effect can be seen in Table 1 which shows how insulating spacers reduce both the frame and edge-of-glass U-values for various components of a vinyl slider. In each case the center-of-glass U-value is 0.116 BTU/hr-ft²-°F. All the U-values are reported in BTU/hr-ft²-°F.

🔊 **USERS SPEAK UP ABOUT THE IG U-VALUE** 🔊

| | Aluminum Spacer | | R1 Spacer | | R5 Spacer | |
|-------------|-----------------|--------|-----------|--------|-----------|--------|
| Description | U-frame | U-edge | U-frame | U-edge | U-frame | U-edge |
| head | 0.40 | 0.27 | 0.34 | 0.19 | 0.31 | 0.15 |
| sill | 0.37 | 0.25 | 0.30 | 0.18 | 0.27 | 0.15 |
| jamb | 0.46 | 0.27 | 0.40 | 0.19 | 0.36 | 0.15 |
| rail | 0.98 | 0.26 | 0.80 | 0.20 | 0.71 | 0.16 |

Table 1. The effect of various spacers on a vinyl frame. From "Improving the Thermal Performance of Vinyl-Framed Windows," F.A. Beck and D. Arasteh, Proceedings of ASHRAE/DOE/BTECC Thermal Performance of the Exterior Envelopes of Building V Conference, Clearwater Beach FL, December 7-10, 1992.

Second, the IG U-value can overpredict the ability of an insulating spacer to increase thermal performance if the IG unit is used in a non-thermally broken aluminum frame. If two glazing systems are created and one has an aluminum spacer and one has an insulating spacer, the results for the edge-of-glass U-value for the insulating spacer will be lower than for the aluminum spacer. However, if these two units were put into identical non-thermally broken aluminum frames, there would be negligible difference in the edge U-values because the thermal short circuit caused by the aluminum frame would override the possible improvement afforded by the insulated spacer.

🔊 What is the recommended way to model IG units?

The recommended way to model IG units requires use of the FRAME program created by Enermodal Engineering. The full effect of the spacer can be shown without misrepresentation by creating a simple aluminum and a simple wood or vinyl frame within the FRAME program and modeling spacers to obtain values for the frame and edge-of-glass U-values. Although insulated glass manufacturers may not know exactly in which window configuration his/her units will be used, analyzing unit performance within various sample frames provides a better means of comparing unit performance.

🔊 Should the edge correlations be used in modeling fenestration units with aluminum frames?

Edge correlations 2 - 4 in the FRAME LIBRARY were developed at LBL using a two-dimensional finite element computer code, ANSYS. These correlations were formulated based on glazing systems and spacers in conjunction with wood frames. In all cases the top of the spacer was flush with the sightline of the window. The correlations are derived from an average of results of two and three layer glazing systems. Using the edge correlations to model windows with different frame materials, spacer geometry or number of layers may result in misleading results. The best way to ensure accurate results from the WINDOW 4.0 program is to provide case-specific edge-of-glass data either from experimental measurements or from FRAME 3.0 simulations. Be particularly suspect of results obtained for an insulating spacer in an aluminum frame that is not thermally broken. The thermal short circuit caused by such a frame overcomes the advantage gained by the insulating spacer.

☺ **FIXES FOR BUGS AND SNAGS IN WINDOW 4.0** ☺

We have discovered relatively few bugs in WINDOW 4.0. This is an updated list of the *bugs* and *snags* that have been discovered since the release of the program. A *bug* is defined as something that is wrong and needs to be fixed. Fortunately, so far, all the bugs that have been discovered have fixes that the user can implement. A *snag* is defined as a feature of WINDOW that doesn't work as smoothly as it could. Tips for getting around bugs and commonly mentioned snags are discussed below. If you have run into problems with WINDOW that are not addressed in this article, please contact Elizabeth Finlayson either by phone at (510) 486-7179 or by FAX at (510) 486-4089. Our knowledge of how WINDOW performs continues to increase as we hear from people who are using it for specific applications.

BUGS

- ☺ **BUG #1:** There is missing data in the tristimulus file - The file that contains the tristimulus data, used to calculate color properties, has errors at two wavelengths, 0.640 μm and 0.645 μm . The errors resulting from using the incorrect data are minor.

- ☺ **FIX:** The file in question is found in the \SOLAR subdirectory. Using a text editor modify the CIE64T.DAT file as follows:

*****MAKE SURE YOU ARE MODIFYING THE CIE64T.DAT FILE *****
 *****NOT THE CIE64C.DAT FILE.*****

1. Find the existing entry for 0.64 μm . This line really contains data for 0.645 μm . The easiest way to change it is simply to add a "5" after 0.64. The new line should read:

0.645 0.3437 0.1402 0.0000.

2. Now add a line between the entry for 0.635 μm and corrected entry for 0.645 μm . On this line input the data for 0.640 μm :

0.640 .4316 0.1798 0.0000

3. Save the file as a text or ASCII file.

NOTE: If you do not feel capable of making this change, please contact us and we will send you a modified file.

- ☺ **BUG # 2:** The reference for the paper including the algorithm for calculating the angular dependence of the optical properties was left out of the manual.

- ☺ **FIX:** The reference is

Furler, R.A. Angular Dependence of Optical Properties of Homogeneous Glasses, ASHRAE Transactions 97 (2), June 1991.

- ⊗ **BUG #3:** Thermal Conductivity of Monsanto Products. The thermal conductivity of Monsanto's laminated glass products that appears in the WINDOW 4.0 GLASS LIBRARY and in the *.MON spectral data files is incorrect.

☺ **FIX:** Monsanto has created a batch file that will make the necessary corrections to both the glass library and the spectral data files. They have asked us to forward all requests for the updated data directly to them. If you are interested in using Monsanto products in a window analysis, use the corrected data.

To contact Monsanto write or phone:

Julia Kobis
Monsanto Chemical Company
Indian Orchard Plant
730 Worcester Street
Springfield MA 01151
Phone 413-730-3413

If instead you would like a corrected copy of the spectral data disk please contact us and we will send you one.

*****NOTE*** There is no substantial difference in thermal conductivity between the corrected values of the Monsanto laminates and the DuPont laminates of comparable thickness.**

- ⊗ **BUG #4:** Row 48 of the *DOE2* report is labeled "Overall and Center-of-glass IG U-values." The U-values reported, however, starting in column 38 row 52 are duplicate entries of the center-of-glass U-value.

☺ **FIX:** The omission of the overall U-values is not a problem for users of DOE-2.1E as these values are not used by that program. If you want to use the *DOE2* report for some other reason, call us and we will help you get the information that you need.

- ⊗ **BUG #5:** Unless the angular properties are turned on (by typing "a" while in the OPTICAL PROPERTIES SCREEN, F9) the angular dependence of the Solar Heat Gain Coefficient (SHGC) in the *DOE2* Report may be incorrect.

☺ **FIX:** Turn on the Angular Properties by typing "a" within the optical properties screen. Do this just before you create the printout to avoid unnecessary slow down of the program. If you want a *DOE2* report for more than one window, you must turn on the angular properties for each window separately. The best way to do this is to call the window up on the MAIN SCREEN, then press <F5>. The glazing system for that window will be highlighted. Then press <F9> and turn on the angular properties by typing "a". Press <Esc> twice to get back to the MAIN SCREEN and print out the report.

©FIXES FOR BUGS AND SNAGS©

- ⊗ **BUG #6:** After loading the spectral data files for Southwall Technology products into the GLASS LIBRARY, ID# 1500 - 1506, all the data columns are filled with question marks.

☺ **FIX:** Use the update command on the range from 1500 to 1506 to get rid of the question marks.

SNAGS

- ⊗ **SNAG # 1:** When modeling slider windows, the two glazing systems default to the same width only if all the vertical frame members have the same projected dimension. This holds for the left and rights jambs and the mullion in horizontal sliders and for the head, mullion and sill in vertical sliders. WINDOW requires that the user even out the widths of the glazing systems. Evening out the glazing systems is awkward to do by hand.

☺ **FIX:** After you have specified the frame elements for the window, move the cursor to the TYPE field and push the down arrow and then push the up arrow. The window type you desire will be restored and the two glazing widths will be the same.

- ⊗ **SNAG #2:** Updating windows in a large window library has a long delay time.

☺ **FIX:** Keep your libraries small. For more information on this subject read the newsletter article on page 6.

- ⊗ **SNAG #3:** Unless the angular properties are turned on (by typing "a" while in the OPTICAL PROPERTIES SCREEN, F9) the angular dependence of the optical properties will not be included in the WINDOW report.

☺ **FIX:** Turn on the Angular Properties by typing "a" within the optical properties screen. Do this just before you create the printout to avoid unnecessary slowdown of the program.

- ⊗ **SNAG #4:** If the Environmental Conditions are defined differently on the MAIN SCREEN and in the GLAZING SYSTEM LIBRARY, the temperature profile in the WINDOW report is incorrect.

☺ **FIX:** When creating a WINDOW report make sure that the Environmental Conditions are defined the same on the MAIN SCREEN and in the GLAZING SYSTEM LIBRARY. WINDOW 4.0 warns you if this is not the case by putting a question mark next to the ID Number of the glazing system as it appears in the window on the MAIN SCREEN.

☺FIXES FOR BUGS AND SNAGS☺

- ☹ **SNAG #5:** WINDOW 4.0 gives message "Spectral data must cover range .35 to 25 microns" for a spectral data file with data that does cover this range.
- ☺ **FIX:** This erroneous error message can happen if you have created a spectral data file that has lines, other than the first line, that are made up solely of comments.
- ☹ **SNAG #6:** The Shading Coefficient does not equal the Solar Heat Gain Coefficient divided by 0.87 as specified in the ASHRAE Handbook of Fundamentals.
- ☺ **FIX:** The value of 0.87 is the Solar Heat Gain Coefficient for double strength glass based on a solar spectral irradiance function with Air Mass 2.0 (Perry Moon's data). In accordance with ASTM E 891, WINDOW 4.0 uses a solar spectral irradiance function with Air Mass 1.5. Using this solar irradiance, the Shading Coefficient for double strength glass is 0.86. This is the value that the Solar Heat Gain Coefficient is divided by to obtain the Shading Coefficient in WINDOW 4.0.
- ☹ **SNAG #7:** Using the Edit All command in the FRAME LIBRARY disables the warning that tells the user that the frame being edited is used in a previously defined window.
- ☺ **FIX:** There is no fix to this problem except to warn the user who relies on this warning feature that they should edit frames one at a time in order to make sure they are not modifying frame elements used in existing windows.
- ☹ **SNAG #8:** The format of the *DOE2* report was incompatible with the prerelease version of DOE-2.1E.
- ☺ **FIX:** This format incompatibility has been corrected in recent versions of DOE-2.1E. If you have an early version that does not contain the revised format, there are two things you must do to make the *DOE2* report readable by the DOE-2.1E program.
1. LINE 10: The spacer ID Number must be in column 15. It is currently in column 16 and must be moved over one space.
 2. LINE 45: The ")" in column 17 should be moved to column 12.
- ☹ **SNAG #9:** The Shading Coefficient reported on line 36 of the *DOE2* report is less than the Solar Heat Gain Coefficient reported on line 35.
- ☺ **FIX:** The Solar Heat Gain Coefficient reported on line 35 is the center-of-glass value. The Shading Coefficient reported on line 36 is the total window value. DOE-2.1E does not use the value on line 36.

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